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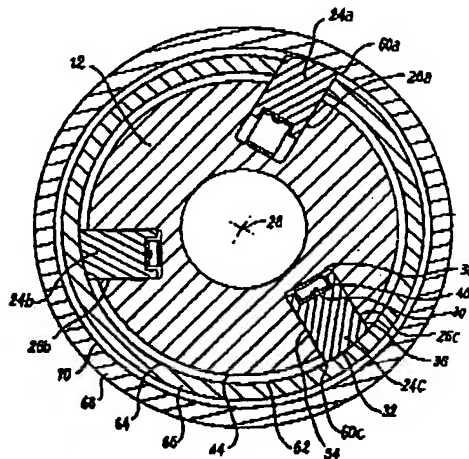
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[Continued on next page]

(54) Title: DUAL FUNCTION CLEANING TOOL



(57) Abstract: A cleaning tool and method of cleaning a liner top in a well bore. The tool includes cleaning elements, typically scrapers, which are arranged eccentrically to an axial bore through the tool. The elements are biased outwardly to contact an inner surface of a polished bore receptacle (PBR) at a position with a curvature to match the PBR and to present leading edges of each element when positioned at a surface of a neighbouring casing. The tool may further provide a top dress mill and act as a packer actuator sub. This provides a tool which performs a number of functions on a single trip in a well bore.

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1 DUAL FUNCTION CLEANING TOOL

2

3 The present invention relates to downhole cleaning tools  
4 for use in oil and gas wells and in particular, though  
5 not exclusively, to a dual function cleaning tool adapted  
6 for cleaning a polished bore receptacle (PBR) and  
7 neighbouring casing on the same trip as setting a liner  
8 including the PBR.

9

10 When a liner is cemented into casing located in a well  
11 bore, the PBR located at the top of the liner together  
12 with that part of the casing immediately above the PBR  
13 (herein referred to as the neighbouring casing) are  
14 susceptible to the influx of cement due to over  
15 displacement when the cement is pumped through the drill  
16 string and liner setting tool. Further when the drill  
17 string and setting tool are removed from the liner,  
18 cement and other debris located between the drill string  
19 and casing will fall back into the PBR and adhere to the  
20 neighbouring casing.

21

22 As the next stage requires the insertion of a sealing  
23 assembly into the liner, the PBR requires to have a

1 smooth cylindrical inner bore on which an effective seal  
2 can be made. Additionally, the inner bore of the  
3 neighbouring casing is used to seal against a packer if a  
4 liner top packer is inserted, and thus requires to  
5 provide a smooth uniform cylindrical surface just above  
6 the PBR.

7  
8 Consequently the presence of cement and debris at the PBR  
9 and/or the neighbouring casing provides a major problem  
10 in ensuring a successful seal. In order to overcome this  
11 problem, cleaning tools are typically run into the well  
12 bore to clean the PBR and the neighbouring casing. A trip  
13 is typically made to clean the PBR and a second trip is  
14 typically needed to clean the casing. Each trip into a  
15 well bore is both costly and time consuming.

16  
17 Due to the decrease in inner bore diameter from the  
18 casing to the PBR, a single trip cannot be made into the  
19 well with a cleaning tool of a fixed diameter to clean  
20 both the PBR and casing. Cleaning tools with cleaning  
21 elements which are biased radially outwards such as that  
22 disclosed in US 4,189,000 to Best, are inappropriate as  
23 the elements cannot be retracted at the point of entry to  
24 the PBR. Thus these tools can only clean the casing.  
25 Additionally as the cleaning elements are not located at  
26 the ends of the widest diameter of the tool, the cleaning  
27 elements cannot effectively access the neighbouring  
28 casing due to its close proximity to the narrower PBR.

29  
30 It is therefore an object of the present invention to  
31 provide a cleaning tool which can provide the dual  
32 function of cleaning both the PBR and neighbouring casing  
33 on the same trip into a well bore.

1

2 It is a further object of at least one embodiment of the  
3 present invention to provide a cleaning tool which can  
4 provide the dual function of cleaning both the PBR and  
5 neighbouring casing on the same trip as the liner is set,  
6 and/or a packer is set.

7

8 It is a further object of at least one embodiment of the  
9 present invention to provide a cleaning tool which can  
10 effectively clean the inner bore of a PBR without  
11 damaging its relatively delicate inner surface while  
12 being able to effectively scrape the harder wearing inner  
13 surface of the neighbouring casing to effectively clean  
14 this also.

15

16 It is a yet further object of at least one embodiment of  
17 the present invention to provide a cleaning tool which  
18 can dress the top of the PBR while also cleaning both the  
19 PBR and the neighbouring casing on a single trip.

20

21 It is a yet further object of the present invention to  
22 provide a method of cementing a liner which includes the  
23 step of cleaning the PBR and neighbouring casing on  
24 tripping out the liner setting tool.

25

26 According to a first aspect of the present invention  
27 there is provided a cleaning tool for use on a work  
28 string, the tool comprising a cylindrical body having an  
29 axial bore running there through, a plurality of cleaning  
30 elements mounted thereon and positioning means to move  
31 the cleaning elements in relation to the body, and  
32 wherein the elements are located eccentrically to the  
33 axial bore.

1  
2 Preferably the cleaning elements are scrapers. Preferably  
3 also each element has an inner face and an outer face.  
4 The outer face may include one or more blades as  
5 scrapers. More preferably the cleaning element is  
6 substantially rectangular in cross-section to provide a  
7 first edge between a side and the outer face.  
8  
9 Preferably the plurality of elements are located in at  
10 least one band around the circumference of the body.  
11 Preferably also the elements of each band are spaced  
12 equidistantly around the body.  
13  
14 Preferably each element is located in a recess of the  
15 body. Preferably each recess is located longitudinally  
16 on the body, eccentrically to the axial bore. Preferably  
17 also each recess has a lip located at each longitudinal  
18 end thereof. The lip will prevent the cleaning element  
19 moving out of the recess.  
20  
21 Preferably the positioning means is a biasing means  
22 located between an inner surface of the recess and the  
23 inner face of the cleaning element. More preferably the  
24 biasing means is a spring. The spring may be leaf, coiled  
25 or conical as are known in the art. Preferably the spring  
26 is held in compression, biasing the element away from the  
27 body.  
28  
29 Preferably the outer face is curved. More preferably the  
30 curvature of the outer face is greater than a curvature  
31 of the cylindrical body.  
32

1 Preferably the curvature of the outer faces of the  
2 elements are selected such that in a first position  
3 wherein the outer faces are proud of the body, the outer  
4 faces define a cylindrical surface centralised to the  
5 axial bore. Preferably also in a second position wherein  
6 the outer faces are located outwardly of the first  
7 position, the first edge of each element provides a  
8 leading edge of a scraper.

9

10 Preferably the outer face comprises a material being  
11 softer or more malleable than the material of a PBR. In  
12 this way the PBR cannot be damaged during scraping. The  
13 material of the outer face may be brass.

14

15 Preferably also the elements include a profiled end. The  
16 profiled end may be tapered. In this way, they allow a  
17 sleeve, such as a PBR, to move the elements inwards  
18 towards the body if the tool is inserted into a PBR.  
19 Alternatively, the profiled end may provide a stop. In  
20 this way, the stop which may be a shoulder, prevents  
21 movement of the tool into a PBR whose top overlaps the  
22 stop.

23

24 Preferably the stop comprises a ledge facing the PBR.  
25 Advantageously the ledge comprises a mill. In this way a  
26 topdress mill is provided for the PBR.

27

28 According to a second aspect to the present invention  
29 there is provided a method of cleaning a liner top, the  
30 method comprising the steps;

31

32 (a) inserting a tool according to the first aspect into  
33 a liner;

- 1 (b) running the tool and liner together into a well  
2 bore;
- 3 (c) setting the liner at a casing in the well bore;
- 4 (d) rotating and/or reciprocating the tool to clean an  
5 inner surface of a PBR on the liner with the  
6 cleaning elements;
- 7 (e) pulling the tool from the PBR, so that the cleaning  
8 elements move outwardly to contact neighbouring  
9 casing at the liner top; and
- 10 (f) rotating and/or reciprocating the tool to clean an  
11 inner surface of the neighbouring casing with the  
12 leading edges of the cleaning elements.
- 13
- 14 This is achieved on a single trip into the well bore.
- 15
- 16 The method may include the further step of tripping the  
17 tool from the well bore.
- 18
- 19 The method may include the step of attaching the tool to  
20 a liner setting tool, so that the tool is tripped out  
21 with the setting tool. In this way the casing is cleaned  
22 as the setting tool is tripped from the well.
- 23
- 24 Preferably the method further includes the step of  
25 selecting the curvature of the outer faces to be no  
26 greater than the curvature of the inner surface of the  
27 PBR. In this way, at the first position, the curvature of  
28 the outer faces substantially match the curvature of the  
29 inner surface of the PBR.
- 30
- 31 Preferably also the method may include the step of  
32 running the tool back into the PBR.
- 33

1 Preferably the method may include the step of dressing a  
2 top of the PBR.

3

4 Preferably the method may include the step of setting  
5 down weight on the tool to thereby set a packer.

6

7 An embodiment of the present invention will now be  
8 described, by way of example only, with reference to the  
9 accompanying drawings of which:

10

11 Figure 1 is a part cross-sectional schematic view through  
12 a cleaning tool according to an embodiment of the present  
13 invention;

14

15 Figure 2 is a cross-sectional schematic view through the  
16 tool of Figure 1 at section AA; and

17

18 Figure 3 is an illustration of a tool according to an  
19 embodiment of the present invention at a PBR.

20

21 Reference is initially made to Figure 1 of the drawings  
22 which illustrates a cleaning tool, generally indicated by  
23 reference numeral 10, according to an embodiment of the  
24 present invention. Tool 10 comprises a cylindrical body  
25 12 having an axial bore 14. At an upper end 16 of the  
26 tool 10 is located a box section 18 for connection of the  
27 tool 10 to a work string or a liner setting tool (not  
28 shown). At a lower end 20 of the tool 10 is located a pin  
29 section 22 for connection of the tool 10 onto a lower  
30 section of work string or drill string (not shown).

31

32 Three cleaning elements 24 are arranged equidistantly  
33 around the body 12. Each element 24 is located in a

1 recess 26. Each recess 26 is rectangular and arranged on  
2 the body 12 to be eccentric with the centre 28 of the  
3 bore 14. This is best seen with the aid of Figure 2. Each  
4 recess 26 is offset from a radius drawn from the centre  
5 28. Thus a back surface 38 of the recess 26 is not  
6 perpendicular to a radius drawn from the centre 28,  
7 through the centre of the surface 38, and to the surface  
8 44 of the body 12.

9

10 Each element 24 is generally rectangular in cross-section  
11 and includes inner face 30, an outer face 32, and  
12 longitudinal sides 34,36 respectively. Between the inner  
13 face 30 and the back surface 38 of the recess 26 is  
14 located a linear expander in the form of a leaf spring  
15 40. Spring 40 is attached to the element 24 by a screw  
16 42. The spring 40 is held in compression and thus biases  
17 the element 24 away from the back surface 38 of the  
18 recess 26. In this way the front face 32 of the element  
19 24 protrudes from the outer surface 44 of the body 12.

20

21 At each longitudinal end 46a,b of the recess 26 is  
22 located a lip 48a,b. Lip 48a,b comprises a ring 50a,b  
23 threaded onto the body 12. Ring 50a,b is held in position  
24 by a lock wire 52a,b as is known in the art. Thus when  
25 the tool is rotated the rings 50a,b and hence the lips  
26 48a,b remain in position over the ends 46a,b of the  
27 recesses. The lips 46a,b limit the movement of the  
28 elements 24 away from the back surfaces 38 of the  
29 recesses 26. By this limitation on movement, the springs  
30 40 are always held in compression.

31

32 The outer face 32 of each element 24 comprises three  
33 sections 54,56,58. Outer sections 54,56 taper towards the

1 surface 44 of the body 12 from an inner raised section  
2 56. Inner section 56 is a scraper. The surface of section  
3 56 comprises a blade, but alternatively could comprise a  
4 milling surface. The element 24 is made of brass.  
5 Alternatively only the middle section 56 could be made of  
6 brass, mounted on a base plate comprising the other  
7 sections 54, 58 and the inner face 30. The outer face 32  
8 is curved in the plane perpendicular to the axial bore  
9 14. The curvature of the outer face does not match the  
10 curvature of the surface 44 of the body 12 and is  
11 unbalanced on the face 32. In this way a leading edge 60  
12 is formed between the outer face 32 and a side 34 of the  
13 element 24.

14

15 As can be seen with the aid of Figure 2, when the  
16 elements 24b, c sit proud of the surface 44 of the body 12  
17 at a first position, each outer face 32 lies on a circle  
18 62 having a centre, at the centre 28 of the bore 14. As  
19 is illustrated by the element 24a, in Figure 2, once the  
20 face 32 is in any other position except the first, the  
21 leading edge is presented as the point furthest from the  
22 body 12.

23

24 In use, tool 10 is preferably attached to a liner setting  
25 tool (not shown). The tool 10 is mounted ahead of the  
26 setting tool on a drill string. The curvature of the  
27 faces 32 are selected to be no greater than the curvature  
28 of the inner surface 64 of the PBR 66 intended to be  
29 cleaned. Ideally, as shown in Figure 2, surface 64  
30 matches the circle 62 defined by the faces 32.

31

32 The tool 10 is inserted in the PBR 66 of the liner to be  
33 set in casing 68. The tapered section 58, of the elements

1 24 allow the elements 24 to compress into the recesses  
2 26. The tool 10 can then slide into the PBR 66 and be  
3 held in place by the faces 32 being biased against the  
4 inner surface 64 of the PBR 66. As the faces 32 comprise  
5 of brass, which is a softer material than the steel  
6 typically used for the PBR 66, the elements 24 will not  
7 damage the smooth surface 64 of the PBR 66. With the tool  
8 10 located in the PBR 66, the liner is run in the well  
9 and set using the setting tool as is known in the art.  
10 Cement can be pumped through the bore 14 during the  
11 cementing process to set the liner.

12

13 Once the liner is set, the work string is rotated and or  
14 reciprocated to allow the faces 32 to clean the inner  
15 surface 64 of the PBR 66 to remove any debris or cement  
16 which may have accumulated. As the faces 32 are of a  
17 softer material than the material of the PBR 66 and the  
18 curvatures are similar, the leading edges 60 sweep over  
19 the surface 64 providing a polishing action so that the  
20 surface 64 is left smooth.

21

22 Tool 10 is then withdrawn from the PBR 66 on the work  
23 string. As the elements are freed from the PBR 66, they  
24 will move away from the body 12 under the action of the  
25 springs 40 and the faces 32 will now contact the inner  
26 surface 70 of the neighbouring casing 68. As the  
27 curvature of the faces 32 does not match the curvature of  
28 the inner surface 68, the leading edge 60 will contact  
29 the surface 68. Rotation and/or reciprocation of the tool  
30 10 will cause the edge 60 to scrape the surface 68 and  
31 thereby clean any debris or cement which rests thereon.  
32 This cleaning action is more aggressive than that used in

1 the PBR 66. The casing 68 is thereby cleaned as the tool  
2 10 is withdrawn from the well bore.

3

4 As the elements 24 extend from the body 12, the elements  
5 24 can clean the neighbouring casing close to the PBR.

6 This is particularly useful as liner top packers are  
7 generally set within two feet (50 cm) of the top 72 of  
8 the PBR 66 and the cleaning action therefore provides a  
9 good sealing surface on which to set the packer.

10

11 Any wear of the leading edge 60 will merely cause it to  
12 self-sharpen by virtue of the curvature of the face 32  
13 always meeting the side 34 at an edge.

14

15 In a further embodiment of the present invention the  
16 tapered sections 54, 58 can be replaced by faces arranged  
17 perpendicular to the axial bore 14. This is as  
18 illustrated in Figure 3. Lower surface 54 is now  
19 substantially perpendicular to the bore 14 at angle to  
20 match the top 72 of the PBR 66. The surface 54 includes  
21 a mill 80 which when it contacts the top 72 of the PBR 66  
22 can dress the top, acting as a top dress mill when the  
23 string is rotated. The mill 80 is made of a suitable  
24 material such as carbide. Further, the tool of this  
25 embodiment can be used to provide a stop at the top 72 of  
26 the PBR 66. In this way the tool 10 cannot be pushed back  
27 inside the PBR 66 and so can be used as a packer actuator  
28 sub to set a liner top packer 82, by setting down weight  
29 on the string.

30

31 A principal advantage of the present invention is that it  
32 provides tool which can clean both the PBR and

1 particularly, the neighbouring casing, on the same trip  
2 as a liner is set.

3

4 A further advantage of the present invention is that it  
5 provides a tool with the dual function of providing a  
6 delicate cleaning action on the smooth sealing surface of  
7 the PBR and a more aggressive cleaning action on the  
8 inner surface of the casing.

9

10 Modifications may be made to the invention herein  
11 intended without departing from the scope thereof. For  
12 example, Though scrapers have been illustrated as the  
13 cleaning elements bristles could also be placed on the  
14 outer faces. The number of elements could be varied and  
15 more rows of elements could be mounted on the tool.  
16 Additionally, though movement of the cleaning elements is  
17 provided by a spring, other means such as using hydraulic  
18 pressure against the inner face 30 could be used to move  
19 the cleaning elements outwards from the tool body.

1   CLAIMS

2

3   1.   A cleaning tool for use on a work string, the tool  
4       comprising a cylindrical body having an axial bore  
5       running there through, a plurality of cleaning  
6       elements mounted thereon and positioning means to  
7       move the cleaning elements in relation to the body,  
8       and wherein the elements are located eccentrically  
9       to the axial bore.

10

11   2.   A cleaning tool as claimed in Claim 1 wherein the  
12       cleaning elements are scrapers arranged on an outer  
13       face thereof.

14

15   3.   A cleaning tool as claimed in Claim 2 wherein each  
16       cleaning element is substantially rectangular in  
17       cross-section to provide a first edge between a side  
18       and the outer face.

19

20   4.   A cleaning tool as claimed in any preceding Claim  
21       wherein the plurality of elements are located in at  
22       least one band around the circumference of the body.

23

24   5.   A cleaning tool as claimed in any preceding Claim  
25       wherein each element is located in a recess of the  
26       body, each recess being located longitudinally on  
27       the body, eccentrically to the axial bore.

28

29   6.   A cleaning tool as claimed in any preceding Claim  
30       wherein the positioning means is a biasing means  
31       located in the recess against the cleaning element.

32

- 1 7. A cleaning tool as claimed in Claim 5 wherein the  
2 biasing means is a spring held in compression,  
3 biasing the element away from the body.  
4
- 5 8. A cleaning tool as claimed in any preceding Claim  
6 wherein an outer face of each cleaning element has a  
7 curvature which is greater than a curvature of the  
8 cylindrical body.  
9
- 10 9. A cleaning tool as claimed in Claim 8 wherein the  
11 curvature of the outer faces of the elements are  
12 selected such that in a first position wherein the  
13 outer faces are proud of the body, the outer faces  
14 define a cylindrical surface centralised to the  
15 axial bore.  
16
- 17 10. A cleaning tool as claimed in Claim 9 wherein in a  
18 second position, the outer faces are located  
19 outwardly of the first position, the first edge of  
20 each element providing a leading edge of a scraper.  
21
- 22 11. A cleaning tool as claimed in any one of Claims 2 to  
23 10 wherein the outer face comprises a material being  
24 softer or more malleable than the material of a  
25 Polished Bore Receptacle (PBR).  
26
- 27 12. A cleaning tool as claimed in any preceding Claim  
28 wherein the elements include a profiled end which is  
29 tapered.  
30
- 31 13. A cleaning tool as claimed in any preceding Claim  
32 wherein the elements include a profiled end arranged  
33 to provide a stop.

- 1  
2 14. A cleaning tool as claimed in Claim 13 wherein the  
3 end comprises a mill, so that the tool acts as a top  
4 dress mill.  
5
- 6 15. A method of cleaning a liner top, the method  
7 comprising the steps;  
8 (a) inserting a cleaning tool into a liner;  
9 (b) running the tool and liner together into a well  
10 bore;  
11 (c) setting the liner at a casing in the well bore;  
12 (d) rotating and/or reciprocating the tool to clean  
13 an inner surface of a PBR on the liner with  
14 cleaning elements thereon;  
15 (e) pulling the tool from the PBR, so that the  
16 cleaning elements move outwardly to contact  
17 neighbouring casing at the liner top; and  
18 (f) rotating and/or reciprocating the tool to clean  
19 an inner surface of the neighbouring casing  
20 with the leading edges of the cleaning  
21 elements.  
22
- 23 16. A method of cleaning a liner top as claimed in Claim  
24 15 wherein the tool is as claimed in any one of  
25 Claims 1 to 14.  
26
- 27 17. A method of cleaning a liner top as claimed in Claim  
28 15 or Claim 16 wherein the method includes the  
29 further step of tripping the tool from the well  
30 bore.  
31
- 32 18. A method of cleaning a liner top as claimed in any  
33 one of Claims 15 to 17 wherein the method includes

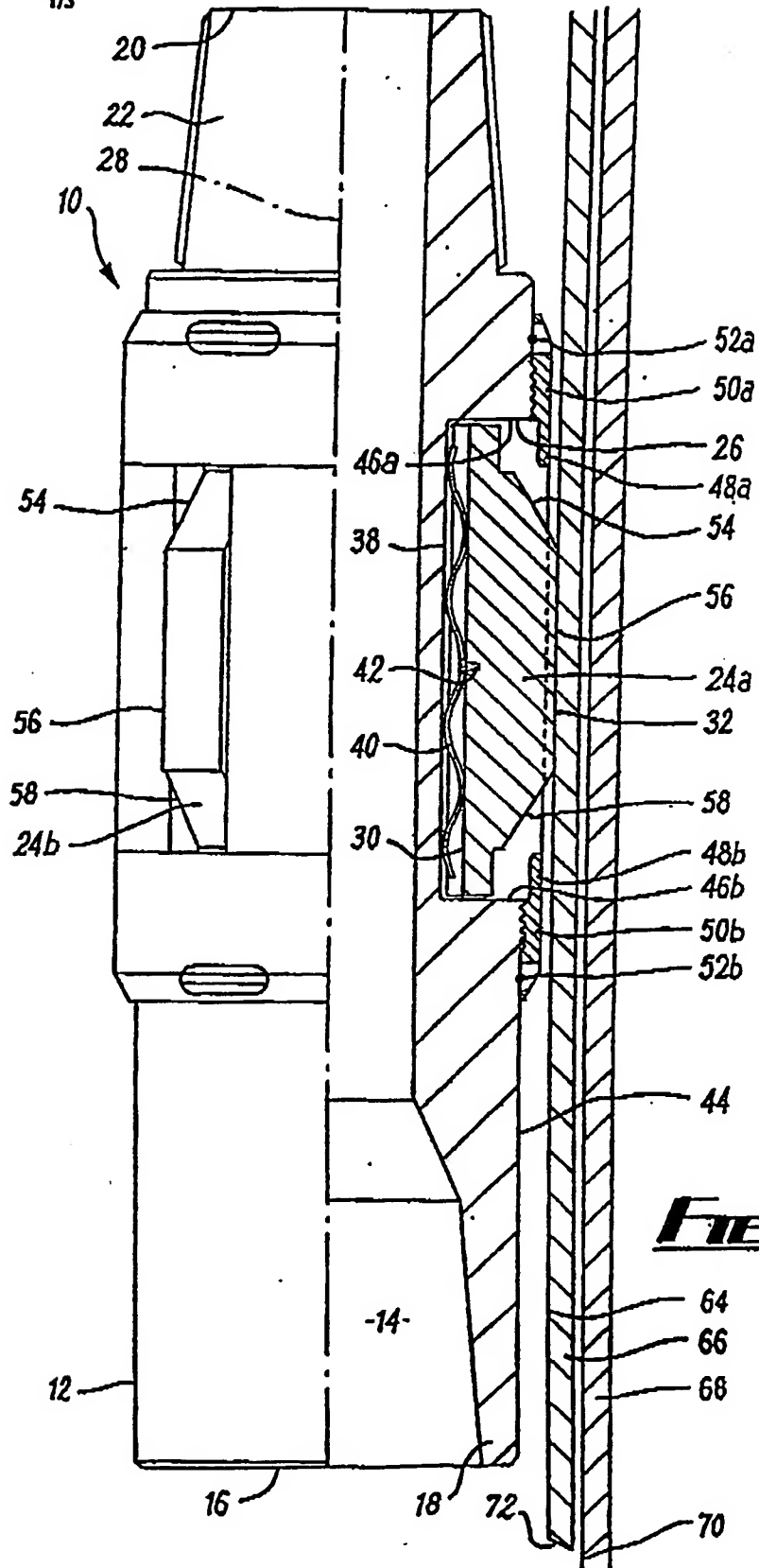
1 the step of attaching the tool to a liner setting  
2 tool, so that the tool is tripped out with the  
3 setting tool.  
4

5 19. A method of cleaning a liner top as claimed in any  
6 one of Claims 16 to 18 wherein the method further  
7 includes the step of selecting the curvature of the  
8 outer faces to be no greater than the curvature of  
9 the inner surface of the PBR,  
10

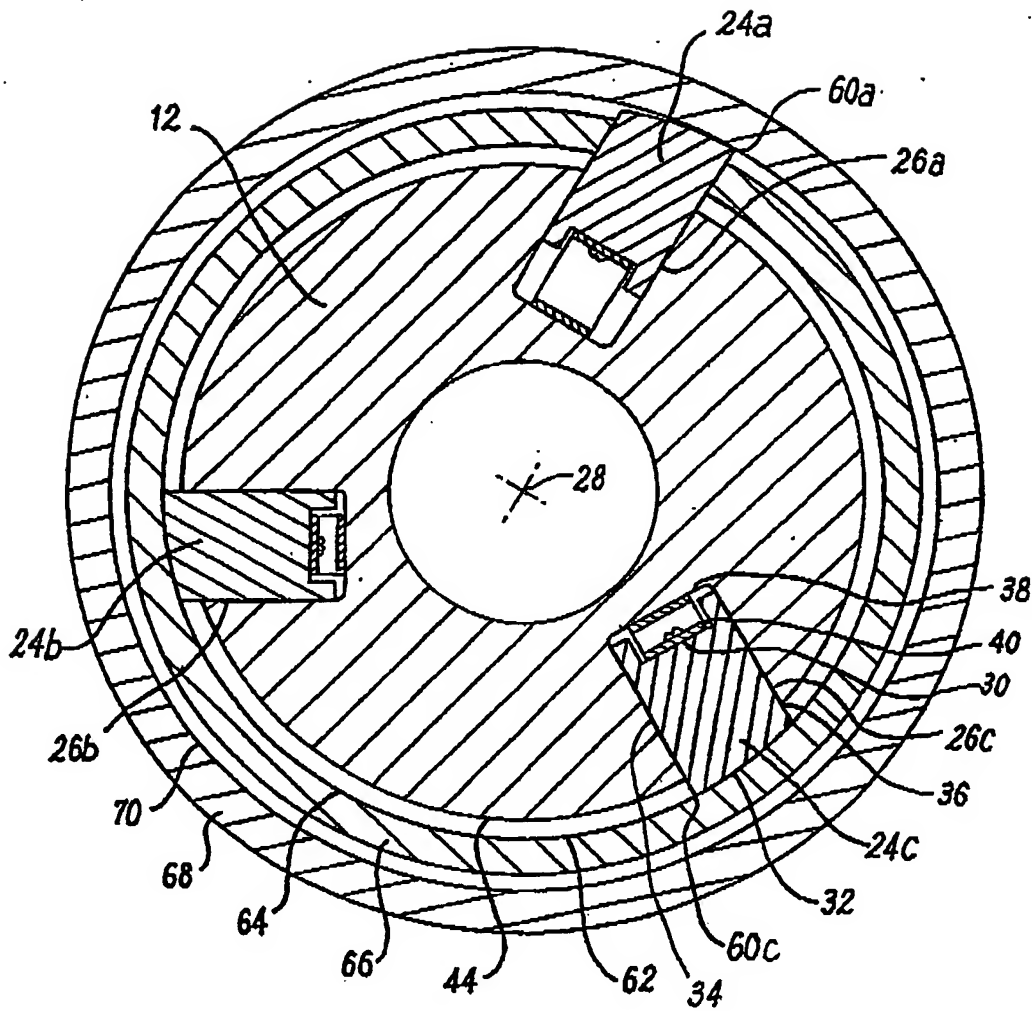
11 20. A method of cleaning a liner top as claimed in any  
12 one of the Claims 15 to 19 wherein the method  
13 includes the step of running the tool back into the  
14 PBR.  
15

16 21. A method of cleaning a liner top as claimed in any  
17 one of the Claims 15 to 20 wherein the method  
18 includes the step of dressing a top of the PBR.  
19

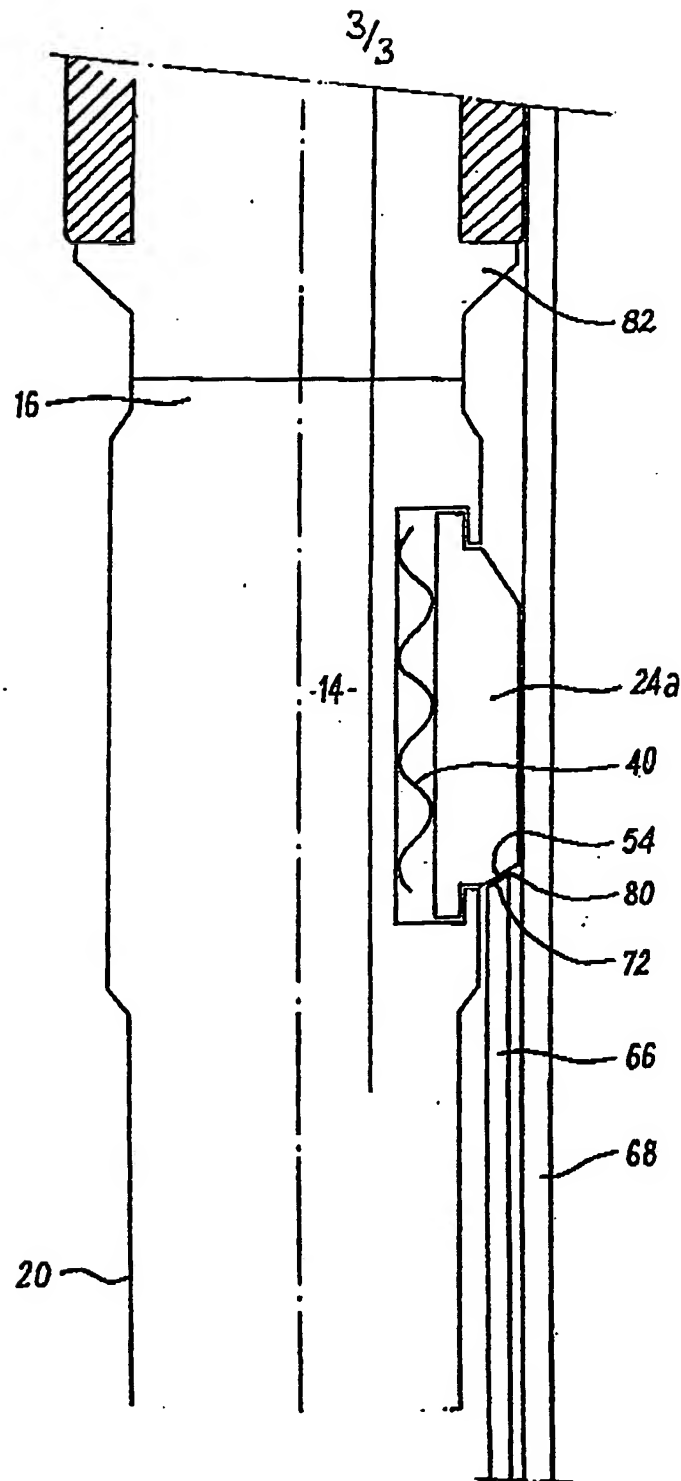
20 22. A method of cleaning a liner top as claimed in any  
21 one of Claims 15 to 21 wherein the method includes  
22 the step of setting down weight on the tool to  
23 thereby set a packer.

***Fig. 1***

2/3



**FIG. 2**



**Fig. 3**